Puberty

1. What is the definition of Puberty?
The ability to accomplish reproduction successfully

2. What are the signs of puberty?
- Ovulation
- Semen Production
- Mating Response

3. What does puberty depend on?
- Body size (and fatness)
- Social Cues
- Environment
- Genetics

4. How does puberty occur?
- Slow progression: The transitions from pre-pubertal to post-pubertal could take weeks to months
- *GnRH stimulates the gonadotropins (LH and FSH)
- Gonadotropins promote gametogenesis (Oocyte/Sperm), steroidogenesis (Estrogen/Testosterone), and development of reproductive tissues

5. What does Testosterone do to the Surge Center in males?
Male: Testosterone freely enters the brain because alpha fetoprotein doesn't bind to it (doesn't have affinity for it). The testosterone is aromatized into estrogen which causes the male brain to be defeminized (so NO surge center develops;minimizes function)

6. How does the Surge Center develop in females?
Female: Alpha fetoprotein (which has an affinity for estrogen) binds to estrogen and prevents the estrogen from entering the brain which causes the female hypothalamus to be feminized (surge center develops)
- Surge Center = Found ONLY in Females
- Tonic Center = Found in BOTH Males and Females

7. What is the difference between Male and Female endocrine profiles?
Male: Gonadotropin releasing hormone (GnRH) does not surge in the male.
LH has small LH episodes that occur every 2-6 hours (tonic surge) where testosterone is secreted soon after each LH episode.

Female: Gonadotropin releasing hormone does surge (E2 and LH surge every 20 days).
High amplitude preovulatory episodes of LH once every several weeks (surge release) and Pulsatile LH episodes between the large pre-ovulatory surges (tonic release)

8. What determines if a female has reached puberty?
- Age of 1st estrus (standing heat)
- Age of 1st ovulation (validated by ultrasound or ovary palpation)
- Age where pregnancy can be sustained without deleterious effects

9. What determines if a male has reached puberty?
- Behavior such as mounting and erection, being able to detect females in heat
- Age of 1st ejaculation
- Age 1st spermatozoa appear
- Age when threshold of spermatozoa is reached (Minimum # of spermatozoa needed to achieve pregnancy)

10. How does GnRH drive puberty attainment?
***__The GnRH pulse frequency (rate) and strength (quantity)__ = puberty attainment. (GnRH neurons are maturing).
As GnRH neuron function increases, puberty begins and is influenced by plane of nutrition (leptin, glucose, fatty acids), exposure to environmental and social cues (season/photoperiod, presence of opposite sex, group housing)

Pre-Pubertal: Minimal GnRH release, gonadotropins (LH and FSH) are secreted at low levels–minimal folliculogenesis or spermatogenesis occurs

Onset of Puberty: Both surge and tonic centers of the hypothalamus undergo changes as there is an increase in GnRH, which then increases gonadotropin pulse frequencies and increases GnRH amplitude–folliculogenesis or spermatogenesis occur.

11. What is the (-) feedback control in GnRH secretion in Males? How does Hypothalamic Sensitivity change?

(-) Feedback (tonic)

As puberty approaches,

- GnRH neuron sensitivity decreases
- (-) feedback of T decreases (takes less T to release GnRH)
- More T and E2 needed, which causes more GnRH, LH, FSH to be released
- Testis develop and puberty occurs

Overtime, GnRH sensitivity to (-) feedback of T and E2 decreases, causing more GnRH to release which produces greater concentration of T and E2

12. What is the (-) and (+) feedback control in GnRH secretion in Females? How does Hypothalamic Sensitivity change?

(-) Feedback (tonic)

Before Puberty:

- Infrequent GnRH pulses
- Some follicular development occurs, but growth is stunted
- Low E2 levels➡No (+) Feedback➡No surge➡No ovulation

Onset Puberty:

- GnRH neuron sensitivity decreases
- (-) feedback of E2 decreases (takes less E2 to release GnRH)
- Greater amount of GnRH released from tonic center
- ⬆ LH Frequency, ⬆ Growth rate of follicles, More E2 produced
- Stimulates GnRH surge center

(+) feedback (surge)

- (+) Feedback of E2
- Change in tonic secretion pattern (⬆E2, ⬆GnRH=⬆LH and FSH, ⬆Follicular size)
- Surge center awakens, causing ovulation

13. What is Kisspeptin?

- A powerful stimulator of the reproductive system that's secreted by hypothalamic neurons that have a direct stimulatory action on GnRH neurons.
- Synthetic kisspeptin increase the level of pituitary reproductive hormones (LH, FSH)

**Puberty DOES NOT occur without kisspeptin

- Adolescents who lack functional kisspeptin system will fail to achieve puberty